

What Is Claimed Is:

1 1. A rotor for use in an electrical
2 machine, said rotor having an axis of rotation and
3 comprising:

4 a first pole piece having a plurality of
5 axially-extending first pole fingers and a first inner
6 rotor portion;

7 a second pole piece having a plurality of
8 axially-extending second pole fingers and a second
9 inner rotor portion;

10 a field coil magnetically coupled with said
11 first pole piece and said second pole piece which when
12 energized magnetizes said first pole fingers and said
13 second pole fingers such that said first pole fingers
14 have a north magnetic polarity and said second pole
15 fingers have a south magnetic polarity;

16 a plurality of permanent magnets having a
17 first set of permanent magnets and a second set of
18 permanent magnets;

19 one of said first set of permanent magnets
20 disposed between one of said plurality of first pole
21 fingers and one of said plurality of second pole
22 fingers, said one of said first set of permanent
23 magnets having a first radially-inward surface, a first
24 radially-outward surface, a first side surface and a
25 second side surface, wherein said first side surface is
26 adjacent to one of said plurality of first pole fingers
27 and substantially extends the length of one of said
28 plurality of first pole fingers, wherein said second
29 surface is adjacent to one of said plurality of second
30 pole fingers and substantially extends the length of
31 one of said plurality of second pole fingers;

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32 one of said second set of permanent magnets
33 disposed between one of said plurality of first pole
34 fingers and the other of said two adjacent said
35 plurality of second pole fingers and having a second
36 radially-inward surface, a second radially-outward
37 surface, a third side surface and a fourth side
38 surface, wherein said third side surface is adjacent to
39 said first pole finger and substantially extends the
40 length of said first pole finger, wherein said fourth
41 side surface is adjacent to said other of said two
42 adjacent said plurality of second pole fingers and
43 substantially extends the length of said other of said
44 two adjacent said plurality of second pole fingers; and
45 wherein said first radially-outward surface
46 and said first side surface have a north magnetic
47 polarity and wherein said second radially-outward
48 surface and said fourth side surface have a south
49 magnetic polarity.

1 2. An electrical machine having a rotor as
2 defined in claim 1.

1 3. An electrical machine having a rotor
2 according to claim 2, wherein said electrical machine
3 is an alternator.

1 4. The electrical machine having a rotor as
2 in claim 2, wherein said plurality of permanent magnets
3 produces permanent magnetic flux from one of said first
4 set of permanent magnets to each of said second set of
5 permanent magnets located adjacent to said one of said
6 first set of permanent magnets such that said permanent

7 magnet flux creates a flux linkage in a stator winding
8 on the electrical machine

1 5. The electrical machine of claim 2,
2 wherein said plurality of permanent magnets produces
3 permanent magnetic flux from said one of said first set
4 of permanent magnets to one of said second set of
5 permanent magnets located adjacent to said one of said
6 plurality of permanent magnets such that said magnetic
7 flux acts in opposition to a field current flux in said
8 first pole piece and said second pole piece, whereby
9 said flux linkage is increased in a stator winding of
10 the electrical machine, thereby increasing output power
11 from said stator winding of the electrical machine.

1 6. The electrical machine of claim 2,
2 wherein said plurality of permanent magnets produces
3 permanent magnetic flux from one of said first set of
4 permanent magnets to one of said second set of
5 permanent magnets located adjacent to said one of said
6 plurality of permanent magnets such that said permanent
7 magnet flux creates a flux linkage in a stator winding
8 on the electrical machine; and wherein said magnetic
9 flux acts in opposition to a field current flux in said
10 first pole piece and said second pole piece, whereby
11 said flux linkage is increased in a stator winding of
12 the electrical machine, thereby increasing output power
13 from said stator winding of the electrical machine.

1 7. The electrical machine of claim 1,
2 wherein each of said plurality of permanent magnets is
3 affixed to the rotor between one of said plurality of

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4 first pole fingers and one of said plurality of second
5 pole fingers.

1 8. A rotor for use in an electrical
2 machine, said rotor having an axis of rotation and
3 comprising:

4 a plurality of axially-extending pole pieces
5 having an inner rotor portion;

6 a plurality of rotor coils, one of said
7 plurality of rotor coils magnetically coupled with one
8 of said plurality of axially-extending pole pieces
9 which when energized magnetizes said one of said
10 plurality of axially-extending pole pieces such that
11 each adjacent one of said plurality of axially-
12 extending pole piece has an opposite magnetic polarity;

13 a plurality of permanent magnets having a
14 first set of permanent magnets and a second set of
15 permanent magnets;

16 one of said first set of permanent magnets
17 disposed between a first adjacent pair of said
18 plurality of axially-extending pole pieces and having
19 a first radially-inward surface, a first radially-
20 outward surface, a first side surface and a second side
21 surface, wherein said first side surface is adjacent to
22 one of said first adjacent pair of pole pieces and
23 extends the length of one of said first adjacent pair
24 of pole pieces, wherein said second surface is adjacent
25 to the other of said first adjacent pair of pole pieces
26 and extends the length of other of said first adjacent
27 pair of pole pieces;

28 one of said second set of permanent magnets
29 disposed between a second adjacent pair of said
30 plurality of axially-extending pole pieces and having

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31 a second radially-inward surface, a second radially-
32 outward surface, a third side surface and a fourth side
33 surface, wherein said third side surface is adjacent to
34 one of said second adjacent pair of axially-extending
35 pole pieces and extends the length of one of said
36 second adjacent pair of axially-extending pole pieces,
37 wherein said fourth surface is adjacent to the other of
38 said second adjacent pair of axially-extending pole
39 pieces and extends the length of said other of said
40 second adjacent pair of axially-extending pieces;

41 wherein said other of said first adjacent
42 pair of said plurality of axially-extending pole pieces
43 and said other of said second adjacent pair of said
44 plurality of axially-extending pole pieces have the
45 same magnetic polarity ; and

46 wherein said first radially-outward surface
47 and said first side surface have a north magnetic
48 polarity and wherein said second radially-outward
49 surface and said fourth side surface have a south
50 magnetic polarity.

1 9. An electrical machine having a rotor as
2 defined in claim 8.

1 10. An electrical machine having a rotor
2 according to claim 9, wherein said electrical machine
3 is an alternator.

1 11. The electrical machine having a rotor as
2 in claim 9, wherein said plurality of permanent magnets
3 produces permanent magnetic flux from said first set of
4 permanent magnets to one of said second set of
5 permanent magnets located adjacent to said one of said

6 first set of permanent magnets such that said permanent
7 magnet flux creates a flux linkage in a stator winding
8 on the electrical machine.

1 12. The electrical machine of claim 9,
2 wherein said plurality of permanent magnets produces
3 permanent magnetic flux from one of said first set of
4 permanent magnets to one of said second set of
5 permanent magnets located adjacent to said one of said
6 first set of permanent magnets such that said magnetic
7 flux acts in opposition to a field current flux in said
8 plurality of axially-extending pole pieces, whereby a
9 flux linkage is increased in a stator winding of the
10 electrical machine, thereby increasing output power
11 from said stator winding on the electrical machine.

1 13. The electrical machine of claim 9,
2 wherein said plurality of permanent magnets produces
3 permanent magnetic flux from one of said first set of
4 permanent magnets to one of said second set of
5 permanent magnets located adjacent to said one of said
6 first set of permanent magnets such that said permanent
7 magnet flux creates a flux linkage in a stator winding
8 on the electrical machine, thereby increasing output
9 power from a stator winding on the electrical machine;
10 and wherein said magnetic flux acts in opposition to a
11 field current flux in said plurality of axially-
12 extending pole pieces, whereby said flux linkage is
13 increased in said stator winding of the electrical
14 machine, thereby increasing output power from said
15 stator winding on the electrical machine.

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14. The electrical machine of claim 8,
wherein each of said plurality of permanent magnets is
affixed to the rotor between an adjacent pair of said
axially-extending pole pieces.

15. A method of increasing rotor flux and
power output in a hybrid permanent magnet synchronous
machine, the method comprising the step of:
generating a permanent magnet flux
circulating from one of a first set of permanent
magnets through a stator to one of a second set of
permanent magnets, said permanent magnet flux
continuing from said one of said second set of
permanent magnets through one of a first set of poles,
an inner rotor portion, and one of a second set of
poles, thereby returning to said one of said first set
of permanent magnets, wherein said permanent magnet
flux in said first set of poles and said second set of
poles and said inner rotor portion acts in opposition
to a field current magnetic flux generated when a field
winding is excited with current.

16. A method according to claim 15, wherein
the step of generating a permanent magnet flux
comprises the steps of:
disposing a first permanent magnet having a
first radially-inward surface, a first radially-outward
surface, a first side surface and a second side surface
between one of said first set of poles and an adjacent
one of said second set of poles, wherein said first
radially-outward surface and said first side surface
have a first magnetic polarity; and

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11 disposing a second permanent magnet having a
12 second radially-inward surface, a second radially-
13 outward surface, a third side surface and a fourth side
14 surface between said one of said first set of poles and
15 the other adjacent one of said second set of poles,
16 wherein said first side surface substantially extends
17 the length of said one of said first set of poles and
18 is located adjacent to said adjacent one of said first
19 set of poles and wherein said third side surface
20 substantially extends the length of said one of said
21 first poles and is located adjacent to said adjacent
22 one of said first poles, wherein said second radially-
23 outward surface and said fourth side surface have a
24 second magnetic polarity, where said first magnetic
25 polarity and said second magnetic polarity are opposite
26 magnetic polarities.

1 17. The method according to claim 15,
2 wherein the step of generating a permanent magnet flux
3 comprises the step of generating a permanent magnet
4 flux circulating from one of a first set of permanent
5 magnets through a stator to one of a second set of
6 permanent magnets, said permanent magnet flux
7 continuing from said one of said second set of
8 permanent magnets through one of a first set of poles,
9 an inner rotor portion, and one of a second set of
10 poles, thereby returning to said one of said first set
11 of permanent magnets, wherein said permanent magnet
12 flux said first set of poles and said second set of
13 poles and said inner rotor portion acts in opposition
14 to a field current magnetic flux generated when a field
15 coil is excited with current.

1 18. The method according to claim 15,
2 wherein the step of generating a permanent magnet flux
3 comprises the step of generating a permanent magnet
4 flux circulating from one of a first set of permanent
5 magnets through a stator to one of a second set of
6 permanent magnets, said permanent magnet flux
7 continuing from said one of said second set of
8 permanent magnets through one of a first set of poles,
9 an inner rotor portion, and one of a second set of
10 poles, thereby returning to said one of said first set
11 of permanent magnets, wherein said permanent magnet
12 flux in said first set of poles and said second set of
13 poles and said inner portion acts in opposition to a
14 field current magnetic flux generated when a rotor coil
15 is excited with current.

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